STEP – A User Perspective

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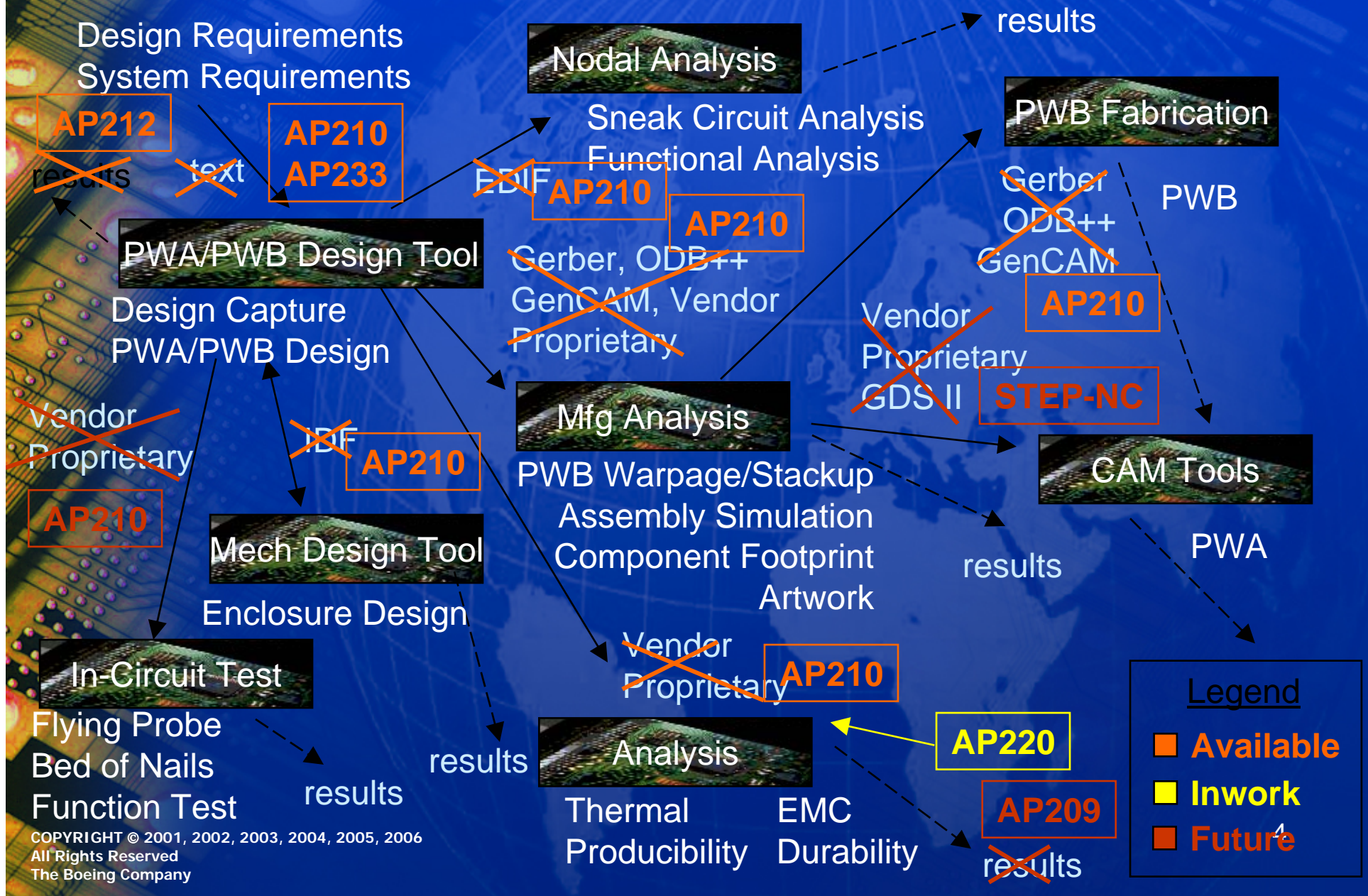
The Boeing Company

206-662-2270

STEP

- STEP is an International Standard
  - Developed and implemented by numerous companies, government entities, and universities.
  - Supports multiple domains
    - Electrical, Mechanical, System Engineering, etc.
  - Focused on information representation and not specific domain technologies
    - Allows for supporting new technologies
    - Supports multiple formats
      - XML, ASCII, KBE, in memory model

Vendor Standards

- Typically driven and controlled by a single vendor or market sector
- Typically provide the company or companies that developed the standard a performance, access, and/or interface advantage.
- Typically domain specific
- Typically proprietary
- Sometimes provide an Application Programming Interface (API)
  - Typically the API software does not support all of the information in the standard
  - Typically made available at an additional cost

Moving from Vendor Proprietary Formats to STEP
focusing on the Electrical / Electronics influenced domains

Design Requirements
System Requirements

AP212

results

text

AP210
AP233

Nodal Analysis

results

PWB Fabrication

Sneak Circuit Analysis

Functional Analysis

EDIF **AP210**

AP210

Gerber
ODB++
GenCAM

PWB

PWA/PWB Design Tool

Gerber, ODB++
GenCAM, Vendor
Proprietary

AP210

Design Capture
PWA/PWB Design

Vendor
Proprietary
GDS II **STEP-NC**

Vendor
Proprietary

EDIF **AP210**

Mfg Analysis

AP210

CAM Tools

AP210

Mech Design Tool

PWB Warpage/Stackup
Assembly Simulation
Component Footprint
Artwork

results

PWA

Enclosure Design

Vendor
Proprietary **AP210**

In-Circuit Test

Flying Probe
Bed of Nails
Function Test

results

Analysis

results

AP220

AP209

Thermal   EMC
Producibility   Durability

results

Legend

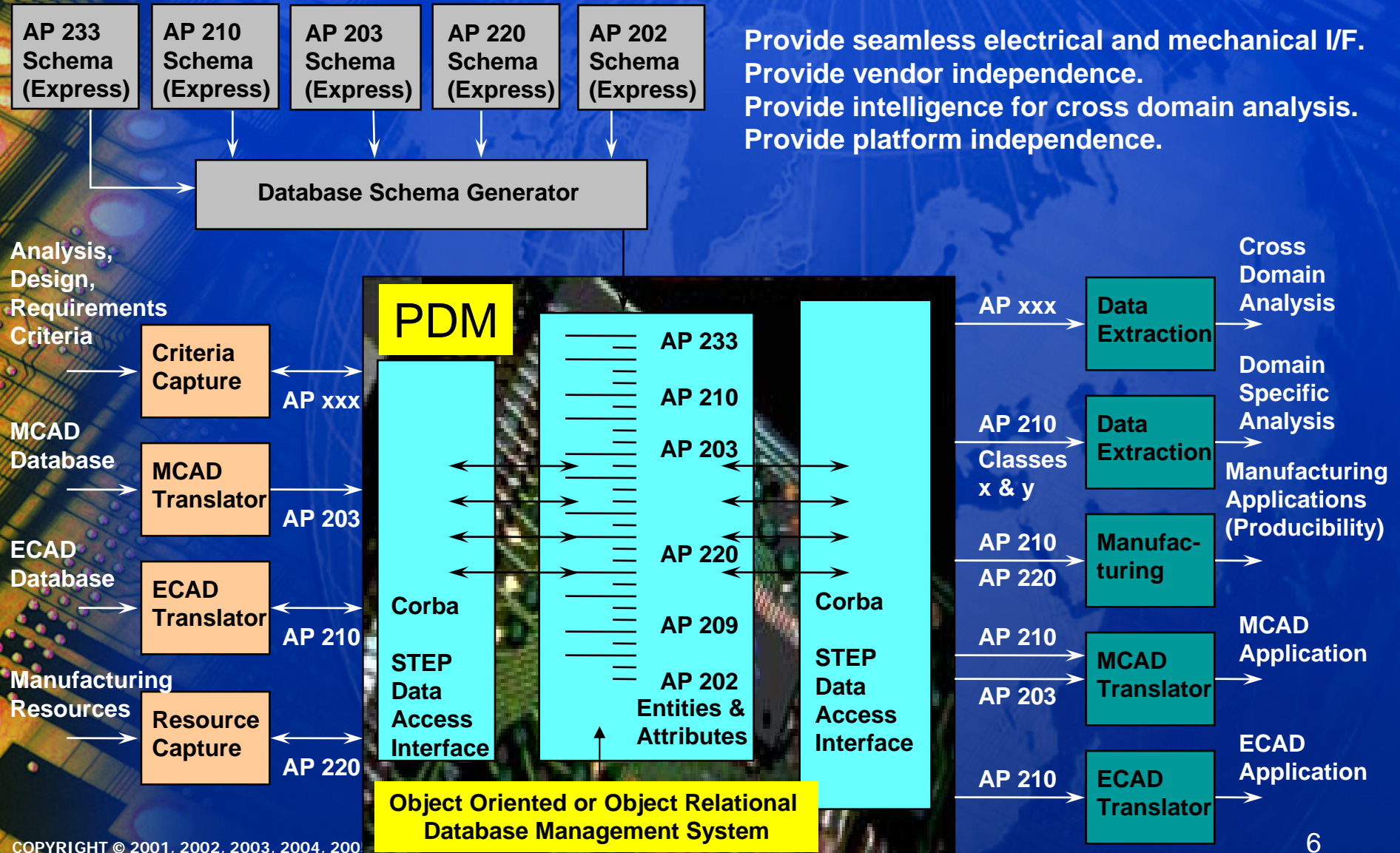■ **Available**
■ **Inwork**
■ **Future**

4

Advantages of International Standards

- The standard extends beyond a single domain.
  - Can create information repositories that contain multiple domains
    - Can provide multiple views of a product (electrical, mechanical, system) using a single browser.
  - Can pose cross domain questions
    - What is the cost to build or manufacture?
  - Can perform cross domain analysis
    - What are the interference or producibility problems

PWA/PWB Inwork Design Repository – Multiple Companies

AP 233 Schema (Express)	AP 210 Schema (Express)	AP 203 Schema (Express)	AP 220 Schema (Express)	AP 202 Schema (Express)

Provide seamless electrical and mechanical I/F.
Provide vendor independence.
Provide intelligence for cross domain analysis.
Provide platform independence.

Database Schema Generator

Analysis, Design, Requirements Criteria

Criteria Capture

AP xxx

MCAD Database

MCAD Translator

AP 203

ECAD Database

ECAD Translator

AP 210

Manufacturing Resources

Resource Capture

AP 220

PDM

Corba

STEP Data Access Interface

AP 233
AP 210
AP 203
AP 220
AP 209
AP 202 Entities & Attributes

Corba

STEP Data Access Interface

Object Oriented or Object Relational Database Management System

AP xxx → **Data Extraction** → Cross Domain Analysis

AP 210 Classes x & y → **Data Extraction** → Domain Specific Analysis

AP 210 / AP 220 → **Manufacturing** → Manufacturing Applications (Producibility)

AP 210 / AP 203 → **MCAD Translator** → MCAD Application

AP 210 → **ECAD Translator** → ECAD Application

STEP in Spacecraft Development

NASA JPL.

This slide provides high level information about how STEP can be applied to the engineering domains that are part of the spacecraft development process.

How the family of STEP Data Standards can be applied to Spacecraft Development

Fluid Dynamics
- **Standard: AP 237**
- **Status**: In Development
- **Software -** TBD
- Boeing, AiAA, (NASA/Ames)

Optics
- **Standard**: NODIF
- **Status**: In Development
- **Software - TBD**
- Minolta, Olympus, ORA

Structural Analysis
- **Standard**: AP209
- **Status**: In Production
- **Software**: MSC Patran, Thermal Desktop
- Lockheed Martin, Airbus, Boeing, NASA-Langely

Thermal Radiation Analysis
- **Standard**: STEP-TAS
- **Status**: In Production
- **Software**: Thermal Desktop, TRASYS, Thermica, ESARAD
- ESA/ESTEC, NASA (JPL & Langely)

Machining
- **Standard:**: STEP-NC/AP224,
- AP 238, and AP2xx (process plan)
- **Status:: In Development / Prototyped**
- **Software::** Gibbs, STEP-Tools, CAMsoft
- **Orgs:** Honeywell, Boeing, GM, NASA-JPL

Propulsion
- **Standard**: STEP-PRP
- **Status**: In Development
- **Software**: TBD
- **Orgs:** ESA, EADS

ElectroMechanical Assembly
- **Standard**: AP210
- **Status**: Prototyped
- **Software**: Mentor Graphics, Eagle, Theorem Solutions, LKSoft, Zuken
- **Orgs:** Rockwell, Boeing, NASA, GaTech, CPES, ATI

Mechanical Engineering
- **Standard**: AP203 Ed. 1 & 2, AP214
- Status: In Production
- **Software** Pro-E, Cadds, SolidWorks, AutoCad, IDEAS, Catia, Unigraphics, Alibre, and others
- **Orgs:** Industry-wide in aerospace and automotive industries (Europe & US)

Inspection (Off-line)
- **Standard**: AP219
- **Status**: In Development
- **Software**: Technomatics, Brown, eSharp
- **Orgs: NIST, DMIS, Boeing, Chrysler, AIAG**

Cabling & Wire Harness
- **Standard**: AP212
- **Status**: Prototyped / In production
- **Software** Mentor Graphics
- **Orgs:** Daimler-Chrysler, GM, Ford, ABB, ProSTEP, Bosch, Rockwell, Siemens

Software Engineering
- **Standard:**:UML
- **Status**: In Production Industry-wide, a STEP AP233 interface to UML is In Development
- **Software:** Rational Rose, All-Together, Argo, Rhapsody
- **Orgs:** Lockheed, NASA, I-Logix,

Systems Engineering
- **Standard**: AP233 / STEP-NRF
- **Status:** In development / Prototyped
- **Software**: Statemate, Doors, MatLab, Slate, Core, RTM, System Arch., TeamWork
- **Orgs:** BAE SYSTEMS, EADS, NASA, CNES, Boeing, Lockheed, Raytheon

PDM
- **Standard:** STEP PDM Schema/AP232
- **Status:** In Production
- **Software:** MetaPhase, Windchill, Insync, Matrix, Share-a-Space, STEP Book, STEP-Tools Inc.
- **Orgs:** Lockheed Martin, EADS, BAE SYSTEMS, Raytheon, NASA. Boeing, Eurostep

Life-Cycle Management
- **Standard**: PLCS / AP 239
- **Status:** In Development
- **Software**: PTC, LSC, AEI, Bonn
- **Orgs:** BAE SYSTEMS, Boeing, Eurostep, NATO, UK MoD

Advantages of STEP

– STEP offers the following advantages:

- capturing engineering terms in a formal manner;

- neutral data exchange between dissimilar systems, both in-house and with suppliers and customers;

- long-term archiving (due to STEP's system-independent architecture);

- flexible migration policies;

- paperless product definition;

- enterprise integration via neutral product database;

- life-cycle maintenance support;

- concurrent or collaborative engineering; and

- worldwide networking communication of product data in open systems

The Challenge of Standards

- Standards change and translators are slow to keep up to date
  - Has more to do with the lack of responsiveness of the translators implementers (which in many cases are vendors)
  - A lot of people do not like Standards as they do not support specific needs of the implementer
    - Typically, the standard supports the needs, but the translator is out of date.

- Standards are developed by committee
  - Individual company needs must be voiced

The presence of XML

- What has worked well for XML
  - Getting tools into the hands of everyone.
  - Allowing pseudo standards to be created very quickly.
  - Allowing rapid integration between limited entities (e.g. 2 companies)
- What has not worked so well for XML
  - Lack of breadth and/or depth in the definition
  - Lack of complete contractual agreements between multiple companies.

Vendors are not elated over STEP

- Do not make money on translators
- Are not (typically) experts on the standard
- Do not control its content or direction
- Are sure you are going to switch to another vendor (by using STEP)
- Provides them no advantage over the competition (can slow the throughput of information)
- Some vendors do not allow storage in STEP
  - Concern over showing intellectual property
    - Dassault (can translate through STEP, but not save STEP files).

Implementing STEP

- Locate vendors or third party translator suppliers that support that tools you are using
- Develop use cases with partner companies
- Consider joining with a few of your partners and creating a PDES, Inc pilot
  - Consider joining PDES, Inc.
    - Would provide access to experts
  - Consider creating a Metrology pilot
    - Would be able to focus the end product
    - Direct access to translator companies

Training – STEP is Complex

- Do not provide in depth training on the entities and attributes
  - When was the last time Dassault or Mentor Graphics provided a detailed discussion of the their database representation
    - They do not
    - It is not relevant to the use of the product
    - Entity and attribute names would be not in the vernacular of the domain experts
    - Could be disclosing intellectual property
- STEP has many of the same concerns

Training – STEP is Complex

- Provided in depth training to Boeing personnel
  - AP210, Printed Circuit Board Assembly
  - 4 day training
  - Caused more confusion than understanding
    - Most translations and files use ASCII
    - The files are human readable.
    - They are not typically understandable my domain experts.
    - In hindsight - should have used Binary over ASCII
  - Turned many of the attendees against STEP
    - Difficult to follow and understand
    - Very Information Technology (IT) oriented
    - Vernacular was far away from the domain experts

Training – STEP is Complex

- Find, locate, and hire consultants work with you
  - Will be a significant productivity gain
  - Without knowledgeable individuals time, effort and money can be wasted.
  - Use individuals from
    - PDES Member Companies
      - Some may provide support for free or low cost
    - STEP companies
      - EPM
      - LKSoft (InterCAX)
      - STEP Tools
      - Etc.

Training – STEP is Complex

- STEP usage requires extraction functions
  - Difficult to write complex queries to extract required information
  - Presently working this with multiple teams to make this available
    - AP210, AP203, AP233, etc.
  - Commercial libraries are low level
    - Extract entities or attributes
    - Do not have an understanding of paths to the information required.
  - Commercial libraries are not free.
    - There is a cost involved
    - Varies with companyz

User Experiences

- Developed and implemented STEP based tools
  - Producibility Analysis (for PWBs/PWAs)
  - Durability Analysis
  - Viewers
  - Functional Editors

  - Requires coordination with other STEP enable companies
  - Required creation of PWB Manufacturing standard
    - Worked with PDES, Ins members to develop
  - Required creation of PWA translators
    - Worked with PDES, Inc members to develop and procure

PDES Inc. Activities

- **Producibility Analysis (a joint EM Pilot & CAM-I activity)**
  - Description: Develop and implement a rules based analysis tool for PWAs using STEP.
  - Goal: Implement an automated producibility analysis tool based on the specific manufacturing capabilities of the target company.
  - Participants: Boeing, Rockwell-Collins and University of Illinois, Georgia Tech
  - Focal: Greg Smith - Boeing, Tom Thurman - Rockwell-Collins
  - Milestones:
    - Jan 03 - Sub set of rules, conformance class defined from LKSoft (GT for Rockwell)
    - Jun 03 - 60 rule system to mfg, using a combination of LKSoft converter and simulation data (GT for Rockwell)
    - Aug 04 – Facility sold to BAE Systems

PWA/PWB Producibility Analysis

Codification of Guidelines (Rules Definition)

Manufacturing Capabilities STEP AP220

Company PWA/PWB Guidelines

Rules

STEP AP210

Producibility Analysis Report

PWA/PWB Captured in Mentor Design Tools
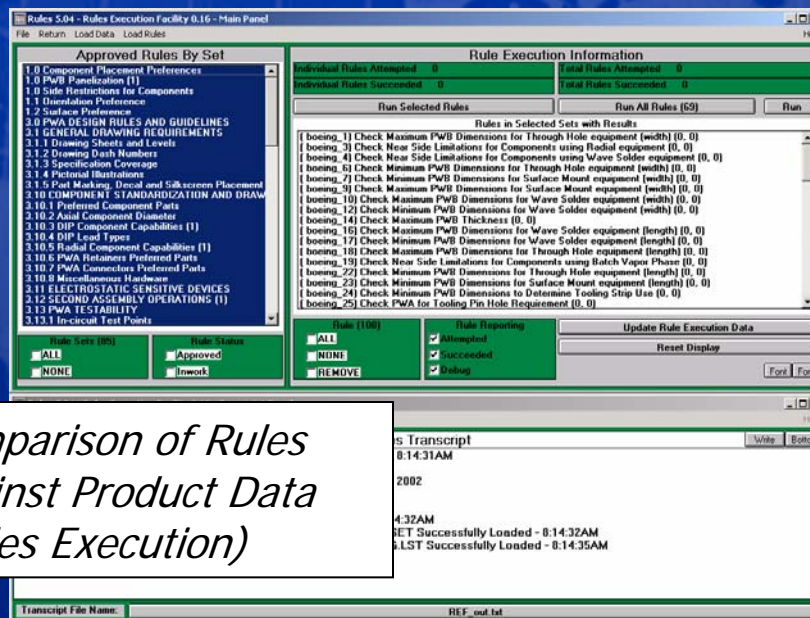
Comparison of Rules Against Product Data (Rules Execution)

PDES Inc. Activities

- **Durability Analysis (related company activity)**
  - Description: Develop a durability analysis tool to support thermal, vibration and failures assessment for PWAs
  - Goal: Provide this analysis capability to all projects as needed within the Boeing company
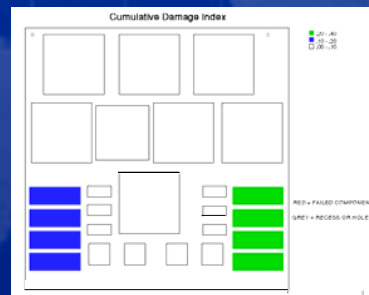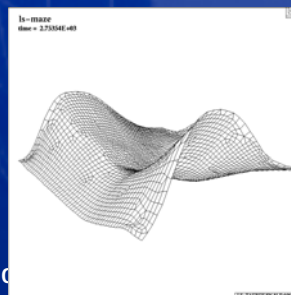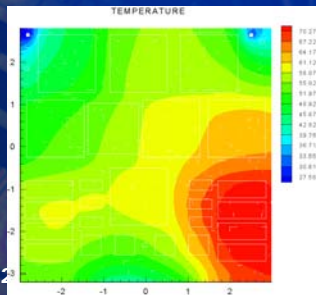 - Participants: Boeing
  - Focal: Mike Keenan / Greg Smith - Boeing

PWA/PWB Durability Analysis – Boeing
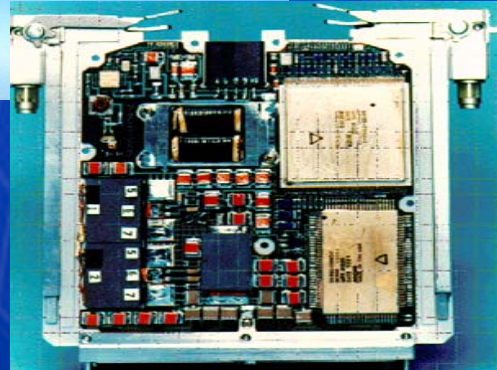
- A metric to identify a failure mechanism and predict time to failure
- Provides assessment of COTS integrity
- Reduces cost of products by concurrent engineering
- Validated on numerous projects

AP210

Thermal Analysis **Vibration Analysis** **Failure Assessment**
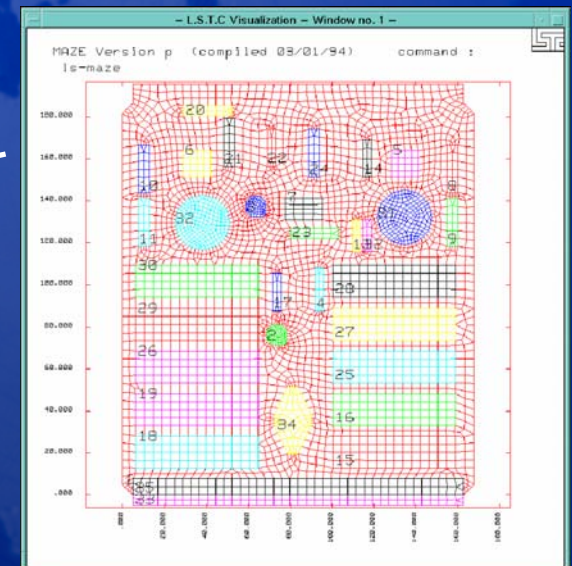
PDES Inc. Activities

- **STEP AP210 Viewer (an EM Pilot activity)**
  - Description: A general PWA/PWB viewer for STEP AP210 data
  - Goal: Provide an inexpensive viewing capability for STEP AP210 data
  - Participants: Boeing, Rockwell-Collins
  - Focal: Mike Keenan - Boeing

AP210 Viewer

AP210 STEP Viewer
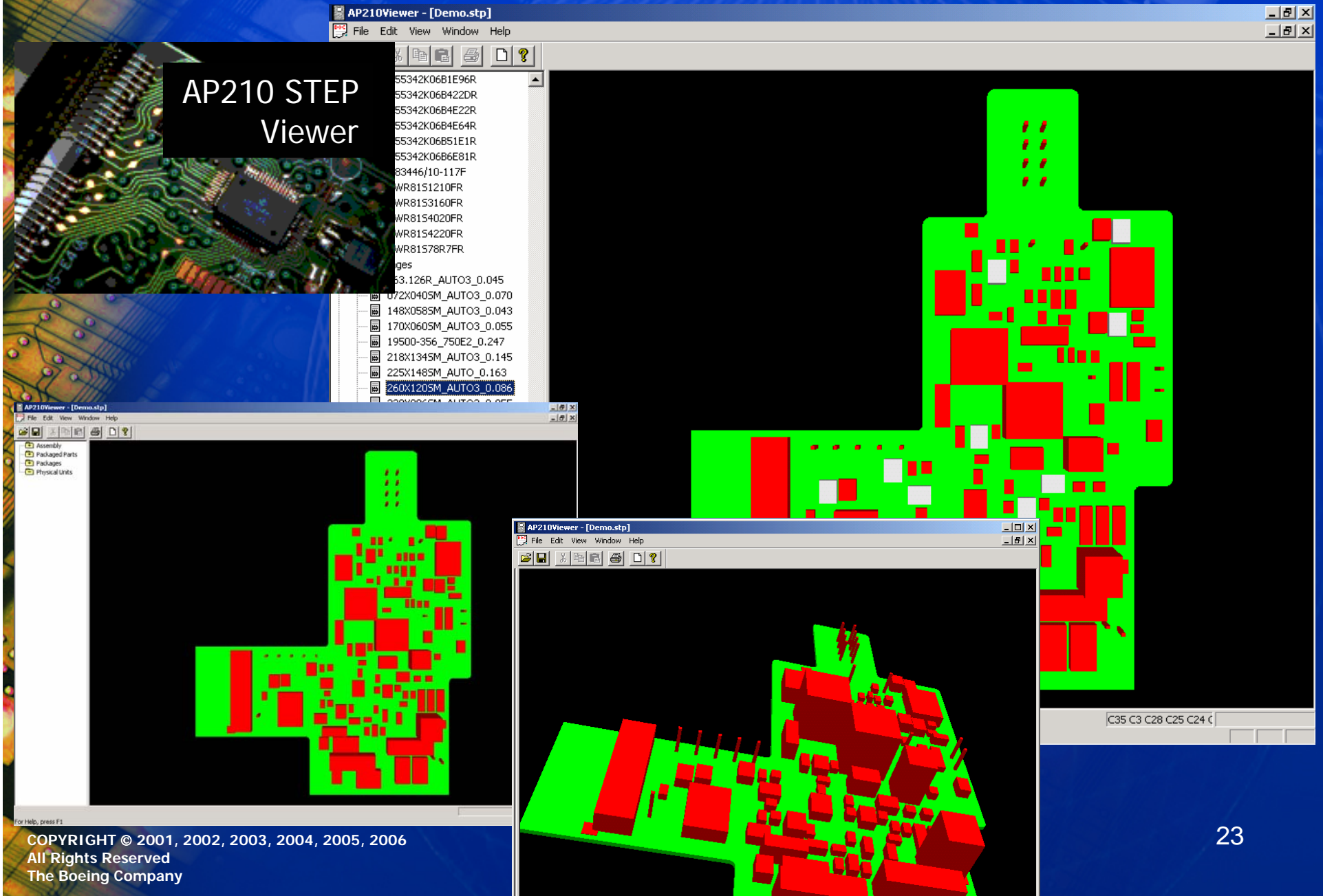
For More Information -

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Questions?